Comment on "Entropy Generation in Computation and the Second law of Thermodynamics", by S. Ishioka and N. Fuchikami (`chao-dyn/9902012` 17 Feb 1999).

In the above cited paper, the authors claim that a more precise expression of Landauer's principle, namely: "[L] erasure of information is accompagnied by *heat* generation to the amount of $kT \ln 2$/bit;" should be: "[IF] erasure of information is accompagnied by *entropy* generation $k \ln 2$/bit." However, as they probably ignore, Landauer's statement about heat dissipation in computation has been *a priori* derived from phase space contraction arguments which can be stated equivalently in terms of entropy. Hence, [L] and [IF] are equivalent, even from Landauer's viewpoint, and there's no need to argue for a difference.

To clarify this point, let us consider the example of the bistable potential (cf. cited paper). According to Ishioka and Fuchikami, entropy is generated when a particle, initially trapped in one side of the bistable potential, is brought to a state where it can move freely between the two wells by lowering the potential barrier. Logically, this leads to the erasure of the information contained in the "position" bit (0 or 1 depending on the initial state in the double well), and, physically, to an increase of the entropy of the particle from $S_i = 0$ (definite memory state) to $S_f = \ln 2$ (unknown final position). Hence, their conclusion [IF].

In Landauer's analysis of the problem on the other hand, a similar conclusion is reached with the difference that the erasure action is somewhat inversed. Landauer considers a particle in a bistable potential which is used to record the position of a particle in another bistable potential. From an outside point of view, the outcome of one measurement of the position generates a random bit that is stored in the recording bistable system. Hence, in the process, the recording particle goes from a definite state of zero entropy (the ready-for-measurement state) to a record state which is 0 with some probability p and 1 with probability $1 - p$, thereby increasing the entropy of the recording device. The erasure of the information then proceeds by putting the recording particle back to its ready-for-measurement state. This leads to a dissipation of *entropy* conveyed as a dissipation of *heat* ([L]).

The two exposed viewpoints differ only by the role of the recording device and the position taken in the act of erasure. In Zurek's terminology (*Phys. Rev.* A 40(8) 4731, 1989), Ishioka and Fuchikami analyze their system from an inside point of view which assigns no probabilities for the recording state, whereas the second analysis considers the measured system and the recording system from the same probabilistic perspective. Evidently, both are correct and lead to the same result, namely, that *entropy is generated in the erasure process*. The dissipation of heat is just an *a posteriori* conclusion which follows from the connection with thermodynamics.

To conclude, let us also note that the "writing process" discussed in the article of Ishioka and Fuchikami can be performed without doing any work. In Szilard's engine, for example, one can insert the partition after waiting until the particle goes on the side that corresponds to the bit to be registered.

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